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# **Fostering place-based coalitions between social movements and science for sustainable urban environments: A case of embedded agency<sup>12</sup>**

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## **Abstract**

The objective of this paper is to contribute to an important debate concerning the interaction between place-based social movements and the science, technology and innovation system. Our central proposition is that place-based social movements can facilitate unique local heterogeneous alliances with key actors of the science and technology system. A process of bricolage can emerge from these alliances whereby social movements are supported by the technical knowledge of the science community, and in turn, the priorities of the scientists are influenced by the agendas of the social movements, leading to new forms of knowledge production. We build on this to argue that these place-based engagements can create significant agency towards changes in socio technical and socio ecological systems in urban environments, especially in societies where regulatory oversight is weaker and social movements in areas that overlap science, technology and innovation are a common expression of civil society demand for change. Our argument is developed through a study of a social movement in defence of an urban wetland in Bogota.

Keywords: Social movement, science system, Colombia, wetland, bricolage, socio technical, socio ecological, urban, network, water, Mixed Methods

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## 1. Introduction

Social movements can be an important mode of expression for civil society in areas that are relevant to the science, technology and innovation system (STI) and to science policy. In particular, social movements are pivotal for pushing forward what Hess has described as “undone” science i.e. that science which tends to be overlooked by the mainstream, is not supported by large firms and would otherwise not be heard or left incomplete (Frickel et al., 2010; Hess, 2015). This paper focuses the discussion on the dynamics of place-based social movements and how the collaboration between social movements and elements of the science and technology system facilitated by co-location of scientists and community activists can be crucial for underpinning radical changes in local socio technical and socio ecological systems<sup>7</sup> and opening new technological paths. The argument is developed through a discussion of an iconic case study of the social movement in defence of urban wetlands in the city of Bogota (Palacio, 2017; Palacio et al., 2003; Palacio and G. Hurtado H., 2005; Ruíz et al., 2011). Using both qualitative and quantitative evidence we suggest that the science system can provide critical technical support for the demands of social movements around the design of urban areas, but also that the knowledge and priorities of the science system itself can be altered and made more relevant to societal needs, in this case improvement of urban habitats and protection of public goods, through its engagement and active participation with grassroots social movements.

Two key concepts are used and combined to frame the discussion. Firstly, the concept of conflict is used to distinguish social movements from other forms of civil society collective action which is linked to the development of agency in policy framing. Secondly, the concept of bricolage has been used to explain how heterogeneous networks of actors reach alignment of aims with limited resources to establish new socio technical configurations (Boschma et al., 2017a; Garud and Karnoe, 2003). Place-based social movements can be analysed through principles of bricolage via the expansion of collective action and forging of local alliances, incorporating a multiplicity of actors including local academics. As we shall argue, this can provide the distributed resources necessary to achieve important impact at policy levels and on the use of technology on the ground.

The paper draws insights from interview techniques and from analysis of social movement and R&D investment databases. For the latter, commonly used techniques are used to represent changes in the evolution of topics and agendas which we apply to analyse social movements and STI policy priorities (Borgida and Sowa, 2014; Ciarli and Ràfols, 2019; Grauwin and Jensen, 2011). The novelty of our approach is to undertake a mixed method which includes interviews, data visualization and semantic analysis of research agendas and social movement priorities. The approach used can be considered a methodological contribution of how new data sources can be used to measure the social impacts of science and technology. We structure the paper in the following way. Our literature discussion emphasises how an organisational structure based on place based networks for “mobilized publics” represents a particular expression for collective action by civil society that has the ability to overcome local barriers and develop community actions based on embedded bonds of solidarity. This means that in our case, the alliance between civil society and academics and scientists facilitates both alternative framings of the wetlands based on ecological principles, but also a movement that is highly responsive to changing social agendas. The case study evidence is laid

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<sup>7</sup> Socio ecological systems are complex and adaptive relationships between social and ecological structures (Arnaiz-Schmitz et al., 2018). This concept allows us to understand the highly dynamics interaction of ecological and societal change such as society’s biophysical structures, bio history and society-nature coevolution, or regulation, governance, and sustainability transitions.

out in two steps. Firstly, a series of semi structured interviews with activists and leaders of the social movements highlights a rich bricolage mode of organisation based on local innovation and overcoming of local barriers. The organisational characteristics of the movement also created a platform for community involvement in the re-framing of the concept of a socio-ecological system beyond the plans of the city planners that was sensitive to the changing relationship of city residents to the wetlands. Evidence of the changing agendas and link up between the social movement and science systems is also provided through analysis of databases of social movements and R&D investments.

## **2. STI and social movements**

Over the past two decades there has been an increasing plea to include lay knowledge of different types of “users” in scientific research. Greater active participation of for example, patients in health research, small farmers in agricultural research and households in energy research, (not just as passive participants) reflect a change in emphasis from views that the ideal form of knowledge comes from pure science (and associated assumptions concerning universal truths that flow from science), towards recognition of the importance of experiential knowledge of users and an appreciation that socially constructed perspectives on knowledge can also help explain the practice of producing knowledge (Buttel, 1994; Caron-Flinterman et al., 2005)

Research on how social movements can influence science and technology agendas are largely absent not only from Schumpeterian framings of STI but also from most narratives discussing the governance of civil society participation in science. This may be because social movements, as opposed to other forms of civil society participation, are often associated with challenging power relations and can therefore be more difficult to dialogue with and control (Della Porta et al., 2015). Even within academic circles, social movements have at times been described as an “irritant” to the social system (Eder, 2015). This is an important omission for social movements represent an important means by which individuals can engage in collective action to influence the priorities, direction and monitoring of the science and technology agenda and the priorities of national and local government. Moreover, social movements, whether in the form of community grassroots activism or overt protest movements represent a specific form of civil society engagement and therefore require a precise framework of analysis that takes into account its specific features (Fischer et al., 2017).

A spatial analysis of social movements is particularly relevant for science policy because changes in policies arising from social pressures are essentially political processes that are inherently grounded in territorial spaces. Thus, although geographical proximity is just one lens through which social movements can be analysed, it is nevertheless a distinct lens in which cultural meanings, memory and identity are constructed under conditions of conflict (Routledge, 2015). Spatial analysis is particularly relevant for building grassroots coalitions and alignment of views (Harvey, 2008; Warf, 2007) and these social relations, built through dense exchanges, can create identities and strengthen shared narratives, which is a point strongly emphasized by communicative theories (Habermas, 1987) that stress the importance of collective visions and sharing of histories (Tilly and Tarrow, 2007). Moreover, these local movements and alliances are important when taking our discussion out of the strictly scientific field towards areas where scientific knowledge interacts with other knowledge of the mobilized publics (Hess, 2016) and where scientists ally with ecological or other

activists and look to alter research agendas (Smith, 2006). Before entering more directly into an analysis of place-based social movements, some of the defining features of social movements as a particular expression of civil society are laid out.

Social movements are arenas in which individuals and communities are brought together to express a desire for social change. Social movements can represent a vibrant arena for engagement between policy makers both with the lay and mobilized publics and organisations in subordinate positions. Although largely invisible from most mainstream innovation writings, social movements do feature in the science and technology studies (STS) inspired literature - for example grassroots innovation thinking is imbued with notions of social activism and community organising (Fressoli et al., 2014). When it comes to scientific participation in social movements, Hess (2016) pulls together experiences of how this relationship can emerge in table 1 below. For example, science advocacy was particularly effective in the environmental breast cancer movement in the United States, whilst citizen science alliances have been a preferred mode of intervention in the anti-Dam movement in Brazil (McCormick, 2006). A dominant theme running across these movements (mostly based in the USA and Western Europe) is the tension between the appearance of neutrality with respect to political and religious beliefs and the desire by scientists to express opinions on political and policy issues. Only when methods of communication are broken it appears that scientists will engage more directly in the policy issues of the day (Hess, 2016).

	Motivation	Mobilizing structure	References	Examples
<b>Scientific and intellectual movements (SIM)</b>	Dissatisfaction with research agendas. Reform research priorities or research field	University departments, well positioned insiders.	(Frickel and Gross, 2005; Mullins, 1972)	Genetic Toxicology, Eugenic movement, Behavioural genetics
<b>Scientific advocacy and activism</b>	Change public opinion and policy	Boundary organisations and scientific panels, covert advocacy, professional organisation, public interest science organisations (PISOs)	(Moore, 1996)	University role in defence research, climate change.
<b>Citizen-science alliances</b>	Challenge dominant paradigms. Respond to undone science needs of communities	Local communities, alliances, consultation structures,	(Brown, 2005; McCormick, 2006; Zwillinger, 2008)	Safety standards, resistance to construction of hydro-electric dams, environmental injustice of low income African-Americans
<b>Lay Knowledge and Citizen Science</b>	Contest "official" assurances of safety and credibility of experts, assist citizen science	Non-profit organisations, citizen science alliances, participatory mapping	(Kinchy et al., 2014; Williams, 1991)	Volunteer water monitoring, impact of medicines, pollution exposure,

**table 1**

From this discussion we highlight two defining features of social movements that are relevant to our discussion. The first is that the essence of social movements, in contrast to other forms of civil society expression, is conflict under conditions of structural (design of material objects) inequality (Hess, 2015). Conflict, then, becomes a meaningful arena of study within which contesting framings of science, technology and innovation compete and that concern mobilized publics. A relevant example of this could be the appropriate technology movement, that developed a strong critique of powerful top down authoritarian design and contested this with a frame that emphasizes bottom-up, people centred and resourceful design in areas such as health, housing, energy and mobility. These opposing forces can be represented by networks of producers, communities, users and activists who confront hierarchical authority, but can also be integrated into powerful systems or compete amongst each other for legitimacy (Fressoli et al., 2014).

Operationalising the presence (or absence) of contestation which can arise from the conflictual nature of social movements therefore concerns us. (Hess, 2015) suggests that an important space can be built for the study of social movements in science by building a bridge between an emerging STS interest in policy making processes and social movement studies (SMS) around actor-agency roles. This means that rather than treating civil society as an adjunct of science networks, with little ability to contribute to creating scientific knowledge or shaping research agendas (Jamison, 2006), it needs to be treated as an active actor (Frickel et al., 2010) and questions of democracy, accountability, resource mobilization, collective action frames and coalitions and the meanings they

create (which are likely to feature prominently in all-scientist networks) need to be addressed as critical features that define and motivate action (Diani and McAdam, 2003; McAdam, 1999). An important space is thereby created whereby the agency of actors involved in social movements is attached to new metaphors such as entrepreneurship and field construction, which opens up an important area of research around how, for example, community mobilization engenders processes of learning to overcome the limits imposed by the local conditions.

Having discussed the relationship between the concept social movements as an expression of civil society and its role in “undone science”, we address the question of the specific influence and impact of place-based social movement in the priorities and application of science. We side-step recent debates in social movement studies on strategies to influence incumbents (Smith et al., 2014) and instead direct the discussion towards the proposition that place-based social movements can encourage disruptive innovation and the emergence of new local socio technical and socio ecological systems through local or regional responses. Debates in geography of innovation frame the source of these as milieus in which organisational forms such as networks exist in which new narratives and alternatives are crafted. (Levi-Strauss's, (1962) original concept of bricolage – making do with what is at hand – captures an important feature of place-based social movements, which is the capacity of actors to create novel combinations in the context of tight resource constraints (for example low local capabilities, fragmented agendas and unwillingness of policy makers and other actors in power to engage), resourcefulness and improvisation, adaptability and the development of complementary assets (Boschma et al., 2017b; Faulconbridge, 2013; Garud and Karnøe, 2001). Bricolage has been applied in different academic contexts, most notably in entrepreneurship studies (Garud and Karnoe, 2003) to depict the way actors act within their space constraints generate change from new combinations. However, its relevance has not been lost in policy circles. (Garud and Karnoe, 2003) for example identified the continuous interaction between research centres and policy makers as critical to the successful development of turbines for wind energy generation in Denmark. This allowed new policy priorities to be shaped, new standards to be defined and new calls for channelling funding of both research and entrepreneurial activity to take place.

Thus, bricolage emphasises innovations in “shared collective spaces” (Hardin, 1968) by heterogeneous actors, which can lead to unpredictable outcomes (Altglas V, 2014; Baker and Nelson, 2005), although these are bounded by relational interactions in common spaces. The significance of bricolage for our discussion is that it can help to build a bridge between social movements and innovation processes. Social movements can force new ways of thinking and using innovation because they usually incorporate new actors – mobilized publics – into the discussion around the priorities and uses for science, technology and innovations. Establishing alignments between science and social movements and working towards common goals can often help overcome the sometimes hostile environments to disruptive innovations. As Lubitow (2013) suggests, providing scientific credibility to activist demands can facilitate “frame amplification” (such as new narratives, new practices) by actors that share common historical events, cultures and traditions which can act as templates for action.

### 3. Research objectives and methods

Our proposition is that the nature of alliances between social movements and actors in the science system built around unique place-based heterogeneous networks can facilitate the development and construction of new alternative framings for the use of technology and innovation (in terms of socio-technical and/or socio ecological systems). Bricolage invites us to identify the role played by different actors<sup>8</sup> in overcoming resource constraints in different periods of the social movement, such as hostile institutional environments, the absence of alternative practices and low capabilities. An important part of the study involved looking at the interaction processes between social movements and actors insert within the science and technology system. For this purpose, we pay particular attention to social networks as a space for the reconfiguration of alliances. From a social movement perspective, social networks can be understood as resources for the articulation of alliances and coalitions across organisations in bricolage mode. At the same time, movements emerge through multiple types of ties and it is often the interplay between these that defines movement dynamics (Diani, 1996; Diani and McAdam, 2003; Gould, 1995; Mische, 2003; Della Porta et al., 2015).

For the purposes of our data collection, a dual approach was adopted (mixing method). Semi-structured interviews were conducted with leaders and participants of the movements including scientists, youth activists (mainly students) and neighbours involved in the social movement (details below). These interviews allowed us to build a time line of the evolution of the social movements, gain insights into the evolving alliances, strategies to overcome limits (bricolage) and the narratives that framed the socio-ecological system of the wetlands. Secondly, taking advantage of the availability of data on social movements and R&D investment, a semantic analysis using social network analysis was conducted to trace the relationship between social movement priorities and the science system through R&D investments within the geographical boundaries of water-related social movements in Bogota. Our main objective here was focussed on finding communities of relevant words (for example contamination, flooding and health) around which social movements cluster. Similarly, for related R&D projects we use metrics to detect structures of networks. Analysis of communities of topics in social network analysis allows us to group topics around which different researchers work and come together (Guimera and Amaral, 2005; Habermas, 1987; Newman, 2018; Wen et al., 2015) to form clusters working in distinct approaches to technology. The overall network map can then show how these problems can be connected and inferences can then be drawn with respect to the alliances formed around specific topics. These communities are represented by highly interconnected nodes that are less connected to nodes in other communities (Blondel et al., 2008; Borgida and Sowa, 2014; Newman and Girvan, 2004; Steyvers and Tenenbaum, 2005). Communities of words are detected through a modularity measure, which is a very well established method to identify a group of nodes which share a high number of ties (Duch and Arenas, 2005). This permits us to establish topics that are priority for social organizations (Fleming et al., 2007; Newman, 2018).

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<sup>8</sup> Actors can be represented by groups of individuals (academics) as well as a variety of social organisations, science technology and innovation institutions (such as the environmental secretary of Bogota) or public private companies such as Aqueduct Company of Bogota.



*We analyse the structure of the networks so as to identify if they are associated to small world networks (Amaral et al., 2000; Fleming et al., 2007; Steyvers and Tenenbaum, 2005; Telesford et al., 2011). Small worlds represent networks in which the distances between nodes are very short (most nodes can be reached by a small number of steps), which means that “different voices” are easier to hear and arise from the findings that seemingly unrelated people are surprisingly close in a social space (Travers and Milgram, 1969).*

## **Data collection and analysis**

Data collection therefore occurred in two stages. A first stage consisted of nine semi structured interviews with the participants and leaders of the social movement in the Bogotá wetland (see appendix). These encompassed activists defending the socio-ecological system of Bogotá's wetlands and included a focus group with three social leaders from the “Cow” wetland, a youth leader from Wetlands foundation and the principle leader of the wetland social movement table, a leading Colombian scholar who also participated in the social movement and two former advisors to the District's Department of the Environment. The interviewees represent a broad range of individuals that participated in different aspects of the social movement, although there is more representation from wetlands in the north of city than the poorer middle and south of the city. A second stage of data collection and empirical analysis involved building social networks from two databases. The first of these was a database of social movements based on a compilation of news articles related to social movements and their actions over the last 40 years in Colombia, which was compiled by the *Centro de Investigación y Educación Popular* (CINEP, by its Spanish acronym - Centre for Research and Popular Education). 113 news articles on social movements associated to wetlands and more broadly on water-related topics in Bogotá were collected from local and national journals/newspapers. This was then classified according to date of publication, topics involved, synthesis of relevant news and location. A second database was used that contains information on research and development projects funded by Colciencias, the Colombian administrative department of science, technology and innovation. We searched specifically for projects related to wetlands in Bogotá within the last 20 years. This database consists of 79 records of R&D projects submitted by public and private institutions, although most of them come from universities and research institutions. Each project has information on the title, applicant institution(s), date of approval and main institution-author and characteristics of the project.

Networks from both databases are constituted by words (nodes) and ties are organization involved in project (Colciencias data base) or organizations associated to the news (CINEP). Two words are linked if they were used by at least two social organizations. Words were standardized to a common word using the following criteria: plurals became singulars, adjectives and verbs were transformed to the nearest noun root, no gender-neutral nouns were homogenized to one gender, some synonyms were unified where there was no uncertain about their meaning, and conjunctions, adverbs, articles and pronouns were removed (SOWA, 1991).

Social network analysis was designed as a longitudinal analysis i.e. changes exhibited between sequential networks over defined period. Changes in the words used by certain social organisations over time is considered as evidence of change in topic over time. The key words were chosen from the summary of news pieces from the social movement database and the titles of the funded

projects. In this way, databases were divided in four stages according to the time frame. Social networks in each stage include the records (either projects or news) for the lapse of time defined. For every network built, we measured the modularity (trend towards the formation of communities or highly connected subgroups). This was carried out using Newman and Girvan (2004) algorithm, identifying inner structures into non-isolated words.

Although there is some debate in the literature concerning community detection techniques, until now there is no consensus on which method is best (Fortunato, 2010; Fortunato and Hric, 2016). After some reflection, it was decided to use divisive algorithm (Newman and Girvan, 2004). This is for two reasons<sup>9</sup>. First, this method has been extensively used to identify communities in weighted and undirected networks (Javed et al., 2018). Therefore, it could allow further comparison. Second, Girvan and Newman's (2004) algorithm is based on edge-betweenness score, identifying group of nodes which share edges (structural equivalence) (Yan and Ding, 2012). In other words, it identifies nodes (words) which are strongly connected by their ties (social actors). In view of this, this method permits us to provide a representation of bricolage where multiple voices of social actors appear together.

All communities found were characterized in terms of the topics they encompassed. Networks were plotted using Gephi (Bastian et al., 2009) and node-coloured according to communities' structure. In addition, information derived from the interviews and secondary data allowed us to interpret the semantic networks and the communities. Figures 2 and 3 below show the evolution of the social movements' network over a 40-year period and STI-projects in Bogotá wetlands over a 20-year period respectively. Subsequently we calculated metrics to find the small-world structure. In order to identify the structure of the network, we looked at the combination of short average path lengths  $L$  and relatively high clustering coefficients  $C$ . In addition, we calculated the degree and betweenness centrality to know the distribution of hubs.

#### **4. Social movements in Latin America and contesting framings of the Bogotá wetlands**

A strong tradition exists in Latin America of direct participation of university academics and students in social movements, for example in the grassroots innovation movements, the social technologies network in Brazil and the appropriate technology movement in the 1960s and 1970s (Fressoli et al., 2014). This builds on a tradition of involvement of universities in Latin America in bottom-up social extension activities and the University's third mission to provide extension services to help deprived groups (Arocena et al., 2017; Arocena and Sutz, 2005). Social movements are also more common because of the widespread scepticism of regulatory oversight and the poor confidence in the ability of the state to deliver services. The highly concentrated and uneven nature of regional economic development also creates territorial traditions of social participation which can endow spaces with collective histories, traditions and visions as social organizations respond to specific lived in experiences. Consequently, rather than scientist networks, social movements form heterogeneous networks that draw in and encompass scientists as active participants, which in turn helps to create alternatives to incumbent framings of technology designs.

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<sup>9</sup> We also undertook an analysing using InfoMap algorithm which has used with some extend to analyse co-words networks. This method was mainly developed for weighed and directed networks (Rosvall & Bergstrom, 2008). It bases on the probability flow of random walks. Therefore, it processes a decomposition of the network into modules which have common flows of information. However, it did not provide a good resolution of networks producing several words isolate. Therefore, it did not permit us to identify common "voices" within the network.

The defence of the wetlands social movement in Bogota that is discussed in this paper is a well-documented example of a social movement combining features of citizen-science alliance and lay knowledge that has lasted close to twenty years. The movement brings together 15 city-wide wetland defence networks. Our narrative begins with a discussion of how reframing of the Bogota wetlands has taken place. Table 2 below outlines some of the competing and contrasting framings of how the Bogota wetlands are perceived by three influential organisations and local network for the defence of the wetlands. This is summarised in the column labelled “framing”. The column labelled “network” describes the network of organisations in which each organisation is primarily connected with, whilst the final column, “actions and mobilizing”, describes the principle routines that drive the practices of each organisation or network. Some of the framings complement each other (for example RHSB<sup>10</sup> and DAMA) whilst others are competing and diametrically opposed (RHSB and construction companies). Thus the construction companies frame wetlands as marshes<sup>11</sup> that provide opportunities to build over and expand road building and housing. As a local newspaper describes it “The marshes of the Savannah and, especially, those of the jurisdiction of the District of Bogotá, have traditionally been recognized as wasted lands or mosquito breeding places where the waters stagnate to produce bad odours. No one gives them their biological importance” (El Tiempo, 1991).

<b>Organisation (network)</b>	<b>Framing</b>	<b>Network</b>	<b>Action and Mobilizing</b>
Network of wetlands of the Sabana of Bogotá (RHSB)	Wetlands are ecosystems to be conserved and enjoyed as part of passive recreation for local community as a commons	Heterogeneous networks, community based organisations, local schools, international funding NGOs, local environmental authorities	Grassroots citizen science and lay knowledge, direct action, with local communities
Empresa Aqueducto y Alcantarillado de Bogota (Firm in charge of Bogota water supply)	Wetlands are defined as natural drainage areas of the city and potential parks	World bank, local authorities, consultants, producers and local community	Asphalted paths around wetland, play zones
Local authority environmental management agency (DAMA)	Wetlands are strategic ecosystems that can provide environmental services and social welfare	Estate budget engineering, enterprises, technical and scientific studies, schools.	Asphalted pathways away from lake borders. Maintenance of vegetation of native species, reforestation and some park facilities such as seats and ecological information
Construction companies (formal and informal)	Urban development and housing, land prices, residues for dumping of construction material or build over to expand land for construction, deforestation	Local authorities, law and order institutions, construction finance firms, estate agents	Fill up wetlands with residue construction material, Asphalt lakes for further construction.

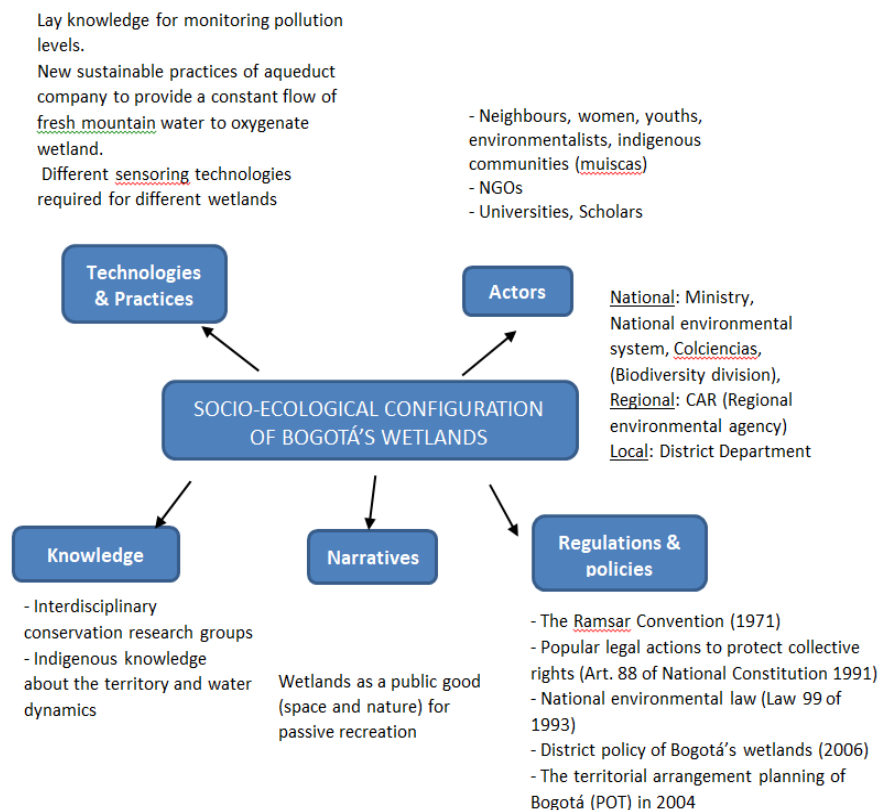
**table 2 here**

Figure 1 below presents a more detailed systemic view of the socio-ecological framing of the wetlands. This underlines the point that underpinning socio-ecological systems is the resilience achieved between different elements of the system to avoid environmental collapse, the

<sup>10</sup> Wetlands Network of Bogota and Savannah, RHSB by its acronym in Spanish.

<sup>11</sup> These economic and political sectors use this word in a pejorative sense.

governance forms that encourage us to think about who are the beneficiaries and losers of particularly systems, that technology is both exogenous and endogenous to the system and that technological choices influence the relationships between users and ecosystems (Smith and Stirling, 2008).



**Figure 1.** Elements from the socio-ecological configuration of Bogotá's wetlands (Source: Geels 2002)

## 5. Conflict and organisation

The initial social movement organisations were motivated by witnessing the progressive environmental deterioration of the wetlands that included pollution, deforestation, the indiscriminate use of agrochemicals in agricultural activities, the dumping of garbage and debris, industrialization (filling in and drying of wetland area) and unplanned urbanization of river valleys and wetlands<sup>12</sup>. As interviewee D comments:

*'I grew up very close to the wetland when Bogotá had rural areas rich in nature... The wetland was my neighbourhood... There was nature and healthy ecosystems... Then, we began to see how water was contaminated, how fauna died – birds, ducks, frogs- ... how wetlands were destroyed'.*

The local ties with students and academics from the nearby Javeriana University were very strong:

*'I studied biology at the Javeriana University... some of my colleagues also lived close to wetlands... we used to share anecdotes from our childhood... during my studies, we did our academic practices in the wetlands... for instance, we analysed the water from wetlands in the laboratories to study the components... professors became interested in the study of wetlands' Interview with environmental activist close to the Conejera wetland (interviewee D).*

Territoriality is a term used by human geographers to describe how social and political power is organized and exercised over space (Brenner et al., 2003) and it was in the territory that these social organisations developed strategies of resistance. Early requests by activists for DAMA, the District Department of Environment and the Aqueduct Company in charge of the water supply to enforce norms of good practice were ineffectual, the department was underfunded and the police chief had been bribed<sup>13</sup>. Consequently, new direct action resistance strategies were adopted (blocking roads, street protest, media exposure, participative monitoring, and environmental lobbying). Blocking of roads leading to the Conejera Wetlands and forcing dump trucks to unload their rubble in front of the municipal offices drew media attention and put the spotlight on corrupt and incompetent politicians. This was combined with citizen science and lay knowledge type activities including participatory popular activities to delimit the borders of the wetlands, clean-up and recovery activities and environmental education with participative monitoring of wildlife and flora involving ecological education by university students to local school students and neighbours.

The alliances forged during this period consolidated bonds of solidarity and provided a platform for a switch of tactics towards legal representation and in particular the *Popular Actions* against the Aqueduct and Sewage Company's (EAAB) proposal to build a water park in the environmental management and preservation area of Cordoba Wetland<sup>14</sup>. *Popular Action* is a clause in the 1991

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<sup>12</sup> These factors were identified by interviews of actors from socio ecological system of Bogotá's wetlands.

<sup>13</sup> This problem was mentioned spontaneously by three of our interviewees who led the social movement process

<sup>14</sup> The Popular Action was introduced into the Colombian Constitution of 1991 as a legal mechanism that can be used by any community to enforce compliance of collective rights. In this case the popular action demanded 'To protect the collective right to have a healthy environment, the existence of an ecological balance, the management and rational use of natural resources to ensure their sustainable development, conservation, restoration or replacement; conservation of animal and plant species; and the protection of

Colombian constitution which decreed that “community groups are to be active participants in the definition of how their community is conformed”. They provide constitutional protection for collective interests related to local spaces, security and the environment. Taking advantage of this constitutional mechanism, in 2000, local solicitors and academics involved in the wetlands movements provided evidence and support to the courts including environmental diagnoses and environmental management plans. In addition, international organisations such as “American Bird Conservancy” that gave financial support to universities to perform research on migratory birds that stopped through the Bogotá wetlands on their migration routes between South and North America (Empresa de Acueducto y Alcantarillado de Bogotá (E.S.P) y Fundación Humedal la Conejera, 2012). Water analysis carried out in the laboratories of the universities substantiated the demands and provided further back-up to the *Popular Action*. As a former advisor to the District Department of Environment comments:

*‘Communities from wetlands were well organised, they wrote academic documents, they planned the wetlands such as Jaboque, La Vaca, Cordoba, Juan Amarillo. They understood pretty well how wetlands worked; they knew where the sources of contamination were... They did environmental management plans without public institutions intervention... then when these institutions called them to design the public policy communities had the academic basics and gave all the inputs’ (interviewee H)*

The *wetlands table* thus provided a platform to work in bricolage form by bringing together residents, academics (especially biologists), students, lawyers and other specialists located in the vicinity of the local wetlands to resist the anti-ecological practices of the construction companies and overcome the passivity (or powerlessness) of state actors. Academics and students, particularly in the northern part of the city, were active participants (in some cases leaders) of the social movements. They assisted in the preparation of evidence for use in *agiprop*, the legal action and support from international organisations. At another level the same academics also led research projects funded by Colciencias, the science, technology and innovation agency, to undertake studies on different aspects of the Bogota wetlands. As discussed in the following section, this provided critical technical-scientific support to the strategy used by the social movement to pressure the local authorities to change urban planning policies.

The successful experience of the popular actions boosted the reputation of its leaders who were transformed into technical experts. After the successful *popular action* court ruling, the principle leader of the social movement was appointed director of the aqueduct company to re-write the company protocols used by the water engineers to manage the wetlands, thus marking a shift in the civil society engagement from one based on resistance and protest to the institutionalisation of wetlands management. Through this process the skills and routines of the company shifted and principles of ecosystem resilience and promotion of the natural balance of wetlands as natural ecosystems (including diverting tributaries of mountain rivers towards the wetlands at 3 litres per second to ensure fresh supply of water) were enshrined.

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areas of ecological importance, the enjoyment of public space, the use and defence of public property and the defence of public patrimony’ (Veredict 254 de 2001 Consejo de Estado).

## 6. Narrative, reframing and changing practices

The initial framing of the wetlands as a socio-ecological system began with the work of urban planners collaborating with ecologists who in the 1990s developed a cohesive city plan of Bogota based on the integration of the biophysical systems and social systems called the *Ecological Main Structure* (EMS) (Van der Hammen and Andrade, 2003; Young et al., 2006). Appendix 2 shows the map with the geographical distribution of wetlands across the city. The plan was inspired by Dutch city planners and brought to Bogota by biological conservation practitioners and was designed to enhance the biological connectivity of rural and urban landscapes. However, as Andrade, Remolina and Wiesner (2013) comment, the plan had large risks of “divergent interpretations” as no integrative concept of the city had yet been developed. Moreover, policy enforcement in the city of Bogota was poor, partly because of the prevalent view held by many city politicians, the aqueduct company and construction firms that wetlands were spaces to be built upon. Therefore, until the protest movements began and Popular Actions decrees were awarded, few regulations existed to protect the ecological systems of the wetlands as city planning authorities succumbed to pressure for urban development.

As discussed, the organisational characteristics of the wetlands social movement (heterogeneous network, place-based, community involvement) created a platform for community involvement in the re-framing of the concept of a socio-ecological system beyond the plans of the city planners<sup>15</sup>. The focus group interview in La Vaca wetland commented that participatory processes between residents covered broad concerns including security and public lighting, trees, public footpaths and natural habitat for wild birds. After much discussion alignment began to emerge of an ecological vision coined by the term “the wetland as a neighbour that was clean, with trees and we could all enjoy” that contested both the developers and aqueduct company.

However, over time, the material conditions of human co-habitation around the wetlands changed significantly. The late 1980s began to see the arrival of thousands of internal migrants displaced by the armed conflict in the country to areas of the city where wetlands existed. Illegal neighbourhoods were established near to Paloquemado market in the Centre of the city which lies next to a wetland. The poor sanitary conditions and lack of infrastructure accelerated the deterioration of wetlands due to the dumping of debris, the pollution by sewage water and industry and the increase of diseases mainly in children. In parallel, in the south-west of Bogotá there was serious flooding caused by the increase in the cause of the Tunjuelito river leading to significant victims and damages. The increase of legal and illegal industries, it was argued, changed the course of the river. The official position of the aqueduct company was that informal neighbourhoods were worsening the flooding of wetlands through dumping of garbage and waste and attempts were made to forcibly remove residents. The residents with the support of the social organisations resisted and refused to move. Following new

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<sup>15</sup> There was an institutional basis for participative action. The re-design of the wetlands was undertaken under auspices of the ECOFONDO Corporation. This organisation was created in 1993, as a result of a thorough consultative process between a group of environmentalist organizations and the national government, represented at that time by the Institute for National Resources (Inderena) and the National Planning Department”. (<http://ecofondo.prueba.webcomercial.com.co/articulo.php?id=248>)

mayoral elections, a sympathetic Bogota local government halted the removals and commissioned new studies to assess problem of flooding.



**Figure 2:** Vulnerable populations affected by poor infrastructure in the vicinity of the La Vaca wetland (Photo reprinted with permission of Dora Consuelo Villalobos Burgos)

The changing material reality around wetland neighbourhoods was closely reflected in the social movement campaigns during this period. This is demonstrated in figure 3 below which illustrates the semantic analysis of social movements in Bogota on wetlands, the methodology of which was described in section 4. We see that between 1975 and 1984 social movements were focused primarily on problems of contamination of water and air as a consequence of industry processes. Concerns about agriculture which reflect some urban-rural tensions as the city of Bogota begins to grow and conflicts arise over the use of the land on the edge of the urban areas also appear.

The years 1985 to 1994 witness an important change as social movements around the wetlands address a more diverse range of topics and in particular risk in territory management and flooding. As the number of social organisations working in defence of wetlands grew, a 'wetlands table' incorporating the different wetlands defence organisations was established to dialogue with the local government. Detailed analysis of the Bogota wetlands movements by Palacios (2017; 2010; Palacio et al., 2003; Palacio and G. Hurtado H., 2005) over many years shows how new organisational arrangement by the wetlands movement facilitated this to become a “collective space” where different communities concerned about wetlands could expressed their concerns. Thus, the wetlands in the more middle class north of the city seeks to recover and preserve the



ecology of the wetland around a narrative of ensuring public space and nature nearby their neighbourhoods. In the poorer neighbourhoods to the south of the city, the narrative focuses on improving housing conditions and the provision of basic public services - electricity, sanitation, among others.

The space of the wetlands defence movement is thus defined through heterogeneous networks with underlying relational and idiosyncratic elements. The social movement captures and expresses the concerns of changing social needs, external events become internalized through the prism of the social movement activists who shift the meaning of a socio-ecological system from a narrow focus on preservation of flora and fauna and the quality of the water towards health, sanitation and urban housing for residents from lower socio-economic groups living in proximity to wetland areas. A common view emerges – fed by scientific arguments around the importance of the wetland for public health and environmental sustainability of the city, but also imbued with the character of the social movement –the importance of resistance as an identity (and its “heroes” who stood up to the construction companies), the defence of collective and democratic spaces and participation (for example in monitoring).

Whilst regional embeddedness gelled the social movement and defined the framing of alternative narratives to the wetlands, the active participation of the scientific community (and in particular biology professors and students) together with social science academics was decisive for reframing and translation of these narratives into new technologies and practices used by the aqueduct company. We analyse this in two ways. Firstly, in addition to the participation of local academics in the grassroots movement, what is remarkable is how the formal science and technology system in the Bogota area also aligns with (or responds to) the concerns of the social movements around the wetlands. Figure 4 shows the pattern of funding of Colciencias in water-related projects in Bogota between 2000 and 2015. These programmes were open calls by Colciencias, the terms of which were defined by the National Council of Science and Technology. In this case it was the Basic Science Programme as defined in the Decree 585 1991.

In the period before the year 2000 much of the funding is focussed on water quality and agriculture. In the 2001-2005 period we see the first indications of the STI system specifically funding social science research of the wetlands around “community monitoring” and highlight the growing alignment of research projects in response to social movement concerns in areas such as health. We also observe projects funded by Colciencias on “water, social actors and territory” i.e. social scientists getting involved on research of the wetlands. Finally, figure 4 also shows the existence of some possible synergies as although social organizations specialise on specific topics, there is in some cases the use of common words that link science and social science projects, for example community monitoring with integrated water system, agricultural systems, water contamination which suggests possible synergies<sup>16</sup>. As discussed, this alignment in part reflects the participation of some academics in the social movements, but is also driven by institutional decree; the consequences of the *La Conejera wetland judgment* by the Popular Action decree was that the judge

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<sup>16</sup> The co-location of these academics in the Wetlands social movements and their active contribution to reframing the socio ecological meaning of these wetlands may well explain the interaction between different disciplinary groups at this micro level.

ordered scientific studies to be undertaken regarding the environmental damage on the wetlands caused by construction and other activity. Collections of biological, physiochemistry and social information were ordered by the judge as part of the evidence for the Popular Action. These studies were led by academics (and in particular biologists) who had sympathised and participated in the social movements and were also considered technical experts. The funding from these studies was then used to establish a technical base to support a new socio ecological framing and management of the wetlands. The court ruling and the subsequent implementation of the wetland policy involved a new set management of practices based on principles of water ecosystems in Bogotá and included the introduction of different instruments to collect information related to water conditions (Table 3). Public policy on the wetlands was eventually enshrined in Wetlands Decree 247 of 2007 law. This established the wetlands as strategic ecosystems because of the wellbeing that they provide to the city.

Type of Technology	Technology used in Bogotá wetlands
Technologies that provide sensors and information concerning the states of ecological systems.	The water monitoring includes filters, multiparameter, Ph indicators, climatological stations, geological stations, social observatory, geographic information system and sampling of fauna and flora.
Technological change stimulates economic growth and re-structuring of social development that impact upon multiple social-ecological systems.	Water management and the cleaning of water allow improved health conditions especially for children. In particular acute respiratory diseases in children reduced to almost zero.
Cleaner technology improves the efficiency with which material resources are harvested and transformed into valued outputs.	The policies related to reduce contamination in wetlands and the Bogotá river have implied to develop new technologies such as industrial filters and residential wastewater treatment. For instances, el Burro wetland was intervened with biofilters, treatment water machines and some infrastructure construction to improve its oxygen rate.
Technologies are being developed with the specific aim of repairing the environmental impacts of existing (technologically-mediated) activities	Some project to restore flora, fauna and water proprieties were carried out by Bogotá Botanical Garden and the District Department of <u>Environment</u> . These technologies must be developed specifically for the wetlands conditions in Bogotá. For instance, Bogotá Savannah has a specific biodiversity and hydraulic conditions in its rivers and wetlands.
Governance strategies for promoting greater social-ecological systems resilience must consider technology choice, its patterns of use, and its control.	Local actors tried to include projects related to regulation of using, cleaning and contamination water after the wetland policy came into effect. For instance, Bogotá Wetland Policy has a specific topic related to technology where COLCIENCIAS have to include programs for environmental education and social strategies.

**Table 3:** Technology and the Bogota wetland (Source: Technologies for monitoring wetlands in Bogotá. Source: District policy of Bogotá's wetlands (2006), environmental management plans in Bogotá (Empresa de Acueducto y Alcantarillado de Bogotá (E.S.P) y Fundación Humedal la Conejera, 2012; Instituto de Estudios Ambientales (IDEA), 2007). Developed from (Smith and Stirling, 2008)

## 7. Alignment and collaboration of social movement and science systems through social networks analysis

Formal analysis of the dynamic evolution of social movements and science communities around the wetlands in this period can also be analysed through a study of semantic network structures. Table 4 shows that the number of semantic communities (topics taken up by social movements) increases considerably after 1995 from three to nine (table 4).

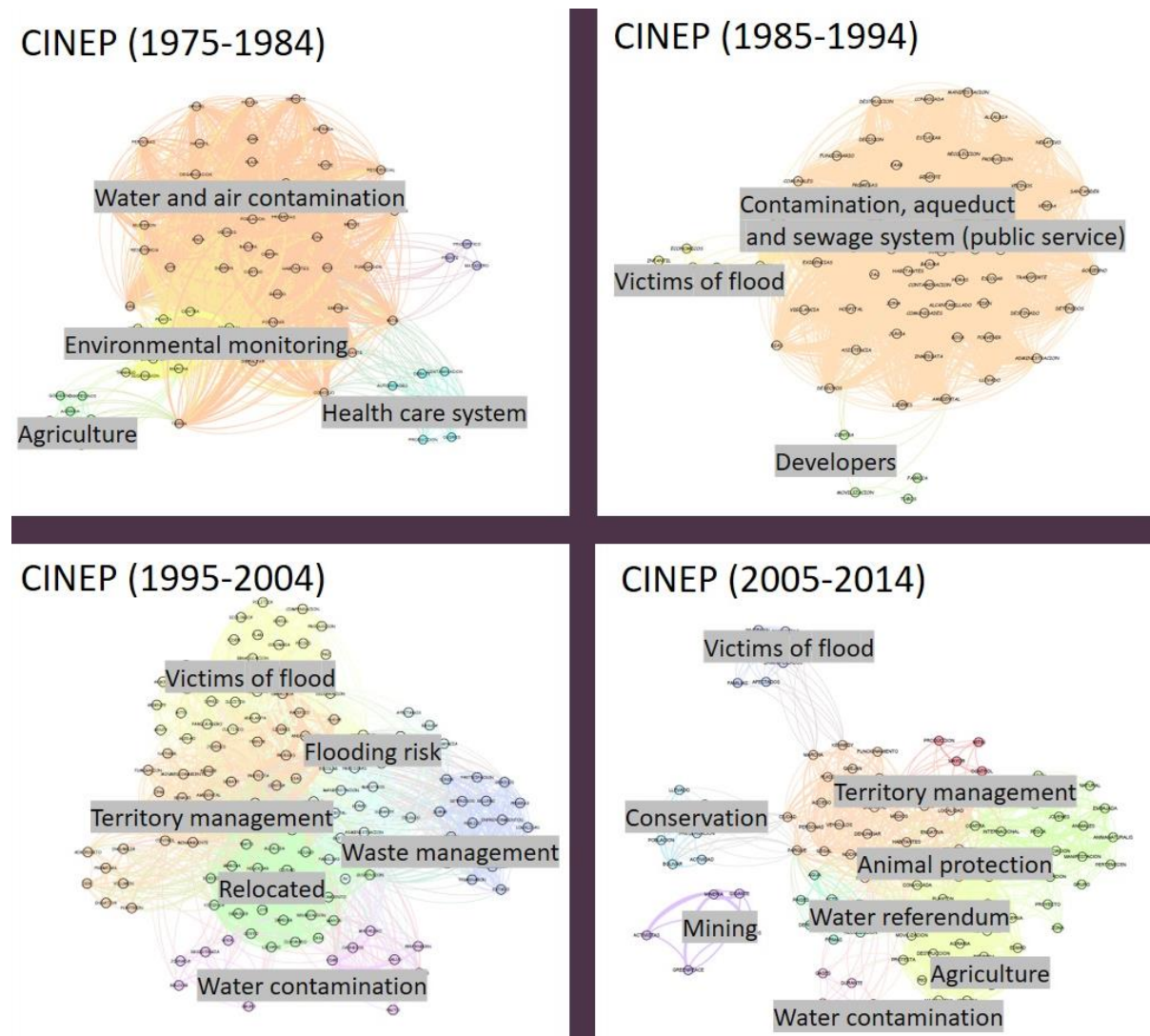
**Table 4:** Semantic network of social movement (Source: CINEP data base).

Time Windows	1975-1984	1985-1994	1995-2004	2005-2014
<b>Node</b>	76	76	143	105
<b>Tie</b>	1408	2119	1966	949
<b>N Communities</b>	5	3	5	9
<b>Average Path Length (L)</b>	1.563859649	1.3154386	1.882793263	2.02459677
<b>Diameter (D)</b>	3	4	3	3
<b>Clustering Coefficient (C)</b>	0.922996290	0.9913735	0.625596292	0.70326523
<b>Density</b>	0.494035080	0.7435088	0.193637349	0.17380952
<b>Degree centralization</b>	0.369009010	0.1949555	0.510688244	0.39133685
<b>Betweenness Centralization</b>	0.131236196	0.0701742	0.106423087	0.16183707

Between 1975 and 1994 we found 5 communities, a small world network with short average path lengths and high clustering coefficient. The high clustering coefficient suggests a large community where different interests were expressed. The value of the clustering decreases significantly after 1994, while the path length increased progressively. Density drops through time windows because new words were integrated into the system. This suggests that as new themes and topics were taken up by the movement, they were not necessarily strongly connected with previous themes (Fleming et al., 2007).

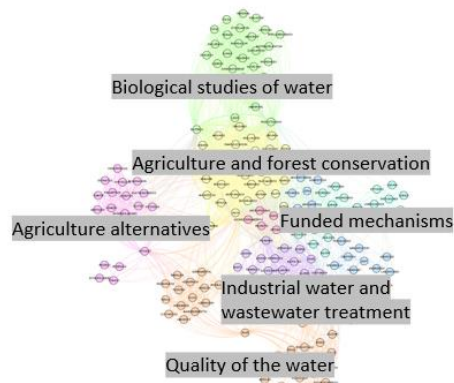
If we compare this semantic network structure to the community of STI research through Table 5 and Figure 3 we see a more pronounced small world structure (i.e. short average path lengths) and relatively high clustering coefficients which means that nodes are well connected. The value of clustering centralization increased between 2000 and 2015, while average path length decreased during the same period. We also found that the value of the density increased significantly from 2011 to 2015. The significance of this result is that because communities are highly clustered and the network is connected overall, new themes can be adopted “efficiently” by other research communities (in other words it is possible to find direct paths between topics) even when the number of nodes increased significantly in the 2011-2015 period. For example, the topic of “Water, Social Actors and Territory” (see figure 4 2001-2005) that reflects interest in how neighbourhoods interact with wetlands, which are associated with completely new set of organisations in the research projects, can quickly influence the rest of the research systems. Potentially, it means that

social movements can have an important influence in the R&D system. Here the applied nature of the research within specific areas with researchers that are mostly co-located facilitated knowledge transfer and multidisciplinary work.

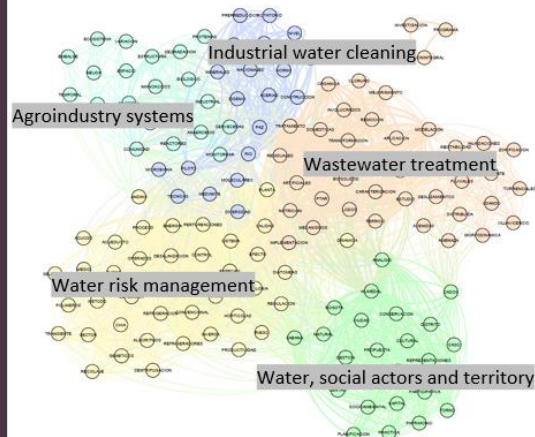


**Figure 3.** Social network analysis social movements in wetlands in Bogotá (Source: CINEP data base). Two words are linked if they were used by a couple of actors. Colours represent communities that were characterized in terms of the topics that they encompassed.

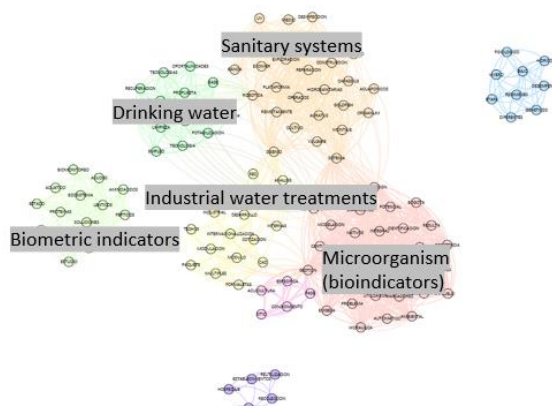
### COLCIENCIAS (-2000)



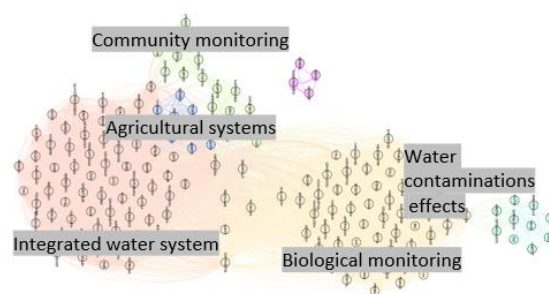
### COLCIENCIAS (2001-2005)



### COLCIENCIAS (2006-2010)



### COLCIENCIAS (2011-2015)



**Figure 4.** Projects funded by COLCIENCIAS (Source: Derived from Colciencias data base). Two words are linked if they were used by a couple of actors. Colours represent communities of topics.

**Table 5:** Semantic network of science funding projects (Source: COLCIENCIAS data base).

Time Windows	-2000	2001-2005	2006-2010	2011-2015
Node	190	150	125	171
Tie	2026	2243	1306	5072
N Communities	8	6	8	6
Average Path Length (L)	2.087051	1.9658166	1.806203044	1.717096663
Diameter (D)	4	3	3	3
Clustering Coefficient (C)	0.665961	0.7178507	0.792250298	0.885683699
Density	0.112838	0.2007159	0.168516129	0.348950808
Degree centralization	0.704098	0.4155632	0.533569368	0.59923425
Betweenness centralization	0.487894	0.1089305	0.224464216	0.210697058

## 8. Discussion and Conclusions

The wetlands social movement can be defined by its defence of a socio-ecological system in a major urban area. The significance of our study lies in that the radically different narratives of urban wetlands around quality of life, city planning and public health, and the new practices that were invented to support this, emerged directly from the need to build broad networks of support to confront and overcome very difficult obstacles to defend these wetlands. Key to understanding this process is the participation and ownership of a broad range of organizations (e.g. La Conejera or La Vaca NGOs or research groups) of the social movement, who developed a complex narrative between conservation, restoration of natural areas, community monitoring and addressing the needs of diverse communities that live on the borders of the wetlands. A further central argument we have made has been that co-location of actors facilitated broad alliances between groups of researchers from the universities and the social movements.

Thus, local networks of activists working in alliance with researchers and academics from the science system based at local universities provided the initial agency to resist further urban encroachment of wetlands. This experience also created the early alternative narratives (stories) and leaders (heroes) of the wetland movement and strengthened the bonds of solidarity. These bonds were important in making the movement responsive to the needs of vulnerable wetland neighbours in the south of the city faced by flooding and public health crises and the re-framing of the socio-ecological system of the wetland from one based on ecological principles and passive recreation, to incorporate questions of public health and infrastructure for vulnerable residents in the middle and south of Bogota. As vulnerable and displaced groups of people moved into the areas surrounding some of the wetlands, the social movement re-framed the meaning of sustainable practices, distanced itself from its own previous framings constructed around narrow environmental standards that were leading to

the forcible removal of vulnerable residents and embraced issues of health and waste disposal. Hence, the nature of “social movements” and the embedded and distributed agency of actors enshrined in its organisation (which allowed a participatory type of bricolage) was accompanied by strong normative directions.

This experience provides some wider insights into debates on the relationship between science and society where social movements are involved. Co-location facilitated firstly the participation of academics and scientists in the provision of evidence to the *Popular Action* strategies through formal research projects funded by the national science and technology agency. This was critical in convincing actors outside of the social movements (municipality, aqueduct company, judges) of the viability of socio-ecological alternatives. Secondly, the territorial embeddedness of social scientists and technical specialists in water management provided an infrastructure of in-depth knowledge and tailored solutions. Thirdly, insights of the Small World Network using semantic analysis suggests that the science and technology system that was mobilized around the wetlands was able to adopt the concerns raised by the social movements, incorporate them into inter-disciplinary projects and translate (or internalise) these into material things (technologies) and practices (monitoring standards, new routines for aqueduct firm, management of waste in wetlands) that are constructed in real spaces to configure a new system. The above underlines the point made elsewhere that scientists through their support can open up what might otherwise be closed policy processes (McCormick, 2006) that can have profound impacts in other social fields (Fujimura and Latour, 1989; Lubitow, 2013) including urban planners, health officials, sympathetic local government (who provide funding) or judges (that can call a halt to unplanned urbanisation).

However, the case study also raised important questions regarding the openness of the science system, its priorities and engagement with civil society. The Colombian wetlands case underlines a two-way learning process between scientist actors and civil society movements. In this process, the social movement brought to the surface changing priorities, agendas and the need for new forms of knowledge production. This is a fertile area for further research for within discussions of citizen science alliances the focus has been predominantly on the knowledge that the scientists can provide as advisors and researchers (Hess, 2013), on the benefits of “consultation” with communities (Sze, 2005) and indeed on “difficulties” of engaging with communities as scientists (Brown et al., 2012) rather than on what the science system can learn from being part of (rather than studying) the social movement. A way forward may be to build on Hess's (2013) point that a primary mobilizing source of scientific change (and learning) lies within relational networks of scientists. This can be extended beyond scientific networks towards learning in bricolage mode through heterogeneous networks (as highlighted in this case) that include a broader range of actors with different backgrounds including social entrepreneurs and community organisations. Learning in this context is specific for it takes place in conflict situations and is more akin to action learning and where the nature of knowledge production evolves in a dynamic tension between new meanings, changing events, practices and materialities.

The policy implications are significant. Local social movements can ally with individuals from local science systems to make them locally embedded in at least five ways: scientists can provide credibility to activist's demands whilst intimate knowledge of local conditions can provide a basis for appropriate technology. Social movements can also be sensitive to needs of local populations and local environment and overcome sceptical perceptions of participation. Finally, the existence and



priorities of social movements can act as a signal to science and technology agencies of the need to intervene proactively. The methods used in the paper also indicate the potential for using different source of data to analyse changing research priorities and management of ecosystems in cities. Different sources of data were used combining interviews, historical records of newspaper and investments in science technology and innovation. Networks were constructed to visualize changing investment priorities and social movements concerns. In this regard, future studies, could try to establish correlations or causal connections in the evolution of different types of networks through techniques such as evaluation of multilayer networks. This would provide more detailed explanation and evidence of interaction between investment priorities and social concerns.

Altglas V. (2014), “‘Bricolage’: reclaiming a conceptual tool, *Culture and Religion*”, *Culture and Religion*, Vol. 15 No. 4, pp. 474–493.

Amaral, L.A.N., Scala, A., Barthélémy, M. and Stanley, H.E. (2000), “Classes of small-world networks”, *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 97, National Academy of Sciences, pp. 11149–11152.

Andrade, G.I., Remolina, F. and Wiesner, D. (2013), “Assembling the pieces: A framework for the integration of multi-functional ecological main structure in the emerging urban region of Bogotá, Colombia”, *Urban Ecosystems*, available at:<https://doi.org/10.1007/s11252-013-0292-5>.

Arnaiz-Schmitz, C., Schmitz, M.F., Herrero-Jáuregui, C., Gutiérrez-Angonese, J., Pineda, F.D. and Montes, C. (2018), “Identifying socio-ecological networks in rural-urban gradients: Diagnosis of a changing cultural landscape”, *Science of the Total Environment*, available at:<https://doi.org/10.1016/j.scitotenv.2017.08.215>.

Arocena, R., Göransson, B. and Sutz, J. (2017), *Developmental Universities in Inclusive Innovation Systems: Alternatives for Knowledge Democratization in the Global South*, *Developmental Universities in Inclusive Innovation Systems: Alternatives for Knowledge Democratization in the Global South*, available at:<https://doi.org/10.1007/978-3-319-64152-2>.

Arocena, R. and Sutz, J. (2005), “Latin American Universities: From an original revolution to an uncertain transition”, *Higher Education*, available at:<https://doi.org/10.1007/s10734-004-6367-8>.

Baker, T. and Nelson, R.E. (2005), “Creating Something from Nothing: Resource Construction through Entrepreneurial Bricolage”, *Administrative Science Quarterly*, available at:<https://doi.org/10.2189/asqu.2005.50.3.329>.

Bastian, M., Heymann, S. and Jacomy, M. (2009), “Gephi: An Open Source Software for Exploring and Manipulating Networks”, *Proceedings of the Third International ICWSM Conference*, available at:<https://doi.org/10.1136/qshc.2004.010033>.

Blondel, V.D., Guillaume, J.-L., Lambiotte, R. and Lefebvre, E. (2008), “Fast unfolding of communities in large networks”, *Journal of Statistical Mechanics: Theory and Experiment*, IOP Publishing, Vol. 2008 No. 10, p. P10008.

Borgida, A. and Sowa, J.F. (2014), *Principles of Semantic Networks : Explorations in the*

*Representation of Knowledge*, edited by John F. Sowa, Morgan Kaufmann.

- Boschma, R., Coenen, L., Frenken, K. and Truffer, B. (2017a), "Towards a theory of regional diversification: combining insights from Evolutionary Economic Geography and Transition Studies", *Regional Studies*, Taylor & Francis, Vol. 51 No. 1, pp. 31–45.
- Boschma, R., Coenen, L., Frenken, K. and Truffer, B. (2017b), "Towards a theory of regional diversification Towards a theory of regional diversification", *Regional Studies*, Vol. 0 No. 0, pp. 1–15.
- Brenner, N., Jessop, B., Jones, M. and Macleod, R. (2003), *State/Space: A Reader.*, Blackwell, Oxford.
- Brown, P., Brody, J.G., Morello-Frosch, R., Tovar, J., Zota, A.R. and Rudel, R.A. (2012), "Measuring the success of community science: The Northern California household exposure study", *Environmental Health Perspectives*, available at:<https://doi.org/10.1289/ehp.1103734>.
- Buttel, F.H. (1994), "Appropriate Biotechnology in Small-Scale Agriculture: How to Reorient Research and Development. By J. F. G. Bunders and J. E. W. Broerse (eds). (Wallingford, UK, CAB International, 1991, pp. 153, £12.50.)", *Journal of International Development*, available at:<https://doi.org/10.1002/jid.3380060116>.
- Caron-Flinterman, J.F., Broerse, J.E.W. and Bunders, J.F.G. (2005), "The experiential knowledge of patients: A new resource for biomedical research?", *Social Science and Medicine*, available at:<https://doi.org/10.1016/j.socscimed.2004.11.023>.
- Ciarli, T. and Ràfols, I. (2019), "The relation between research priorities and societal demands: The case of rice.", *Research Policy*, Vol. 48 No. 4, pp. 949–967.
- Diani, M. (1996), "Green Networks: A Structural Analysis of the Italian Environmental Movement. Mario Diani", *American Journal of Sociology*, University of Chicago Press, Vol. 102 No. 1, pp. 293–295.
- Diani, M. and McAdam, D. (2003), *Social Movements and Networks: Relational Approaches to Collective Action*, *Social Movements and Networks: Relational Approaches to Collective Action*, available at:<https://doi.org/10.1093/0199251789.001.0001>.
- Duch, J. and Arenas, A. (2005), "Community detection in complex networks using extremal optimization", *Physical Review E - Statistical, Nonlinear, and Soft Matter Physics*, Vol. 72 No. 2, available at:<https://doi.org/10.1103/PhysRevE.72.027104>.
- Eder, K. (2015), "No Title", *The Oxford Handbook of Social Movements*, pp. 31–49.
- Empresa de Acueducto y Alcantarillado de Bogotá (E.S.P) y Fundación Humedal la Conejera. (2012), *Plan de Manejo Ambiental Humedal La Conejera*, Secretaría Distrital de Ambiente (SDA), Bogotá, Colombia.
- Faulconbridge, J. (2013), "Mobile 'green' design knowledge: Institutions, bricolage and the relational production of embedded sustainable building designs", *Transactions of the Institute of British Geographers*, available at:<https://doi.org/10.1111/j.1475-5661.2012.00523.x>.
- Fischer, A., Holstead, K., Hendrickson, C.Y., Virkkula, O. and Prampolini, A. (2017), "Community-led initiatives' everyday politics for sustainability – Conflicting rationalities and aspirations for change?", *Environment and Planning A*, available at:<https://doi.org/10.1177/0308518X17713994>.

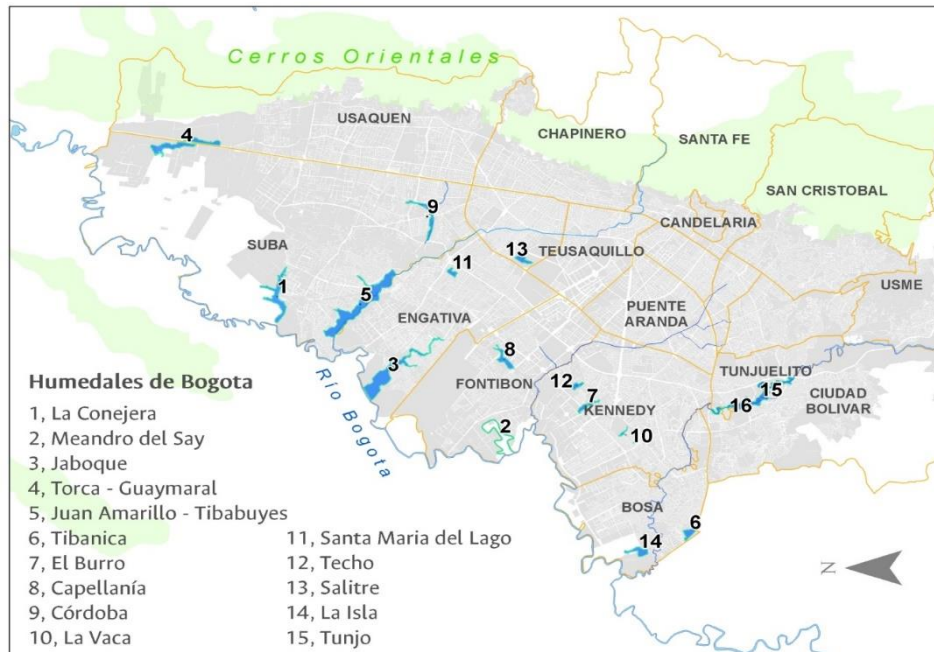
- Fleming, L., King, C. and Juda, A.I. (2007), "Small Worlds and Regional Innovation", *Organization Science*, INFORMS , Vol. 18 No. 6, pp. 938–954.
- Fortunato, S. (2010), "Community detection in graphs", *Physics Reports*, available at:<https://doi.org/10.1016/j.physrep.2009.11.002>.
- Fortunato, S. and Hric, D. (2016), "Community detection in networks: A user guide", *Physics Reports*, available at:<https://doi.org/10.1016/j.physrep.2016.09.002>.
- Fressoli, M., Arond, E., Abrol, D., Smith, A., Ely, A. and Dias, R. (2014), "When grassroots innovation movements encounter mainstream institutions: implications for models of inclusive innovation", *Innovation and Development*, Vol. 4 No. 2, pp. 277–292.
- Frickel, S., Gibbon, S., Howard, J., Kempner, J., Ottinger, G. and Hess, D.J. (2010), "Undone science: Charting social movement and civil society challenges to research agenda setting", *Science Technology and Human Values*, Vol. 35 No. 4, pp. 444–473.
- Fujimura, J.H. and Latour, B. (1989), "Science in Action: How to Follow Scientists and Engineers through Society.", *Contemporary Sociology*, available at:<https://doi.org/10.2307/2073372>.
- Garud, R. and Karnoe, P. (2003), "Bricolage vs. breakthrough: distributed and embedded agency in technology entrepreneurship", *Research Policy*, available at:[https://doi.org/10.1016/S0048-7333\(02\)00100-2](https://doi.org/10.1016/S0048-7333(02)00100-2).
- Garud, R. and Karnøe, P. (2001), "Path Creation As A Process Of Mindful Deviation", *Path Dependency and Creation*, available at:<https://doi.org/10.1561/100.00000006>.
- Gould, R. V. (1995), *Insurgent Identities : Class, Community, and Protest in Paris from 1848 to the Commune*, University of Chicago Press.
- Grauwin, S. and Jensen, P. (2011), "Mapping scientific institutions", *Scientometrics*, Vol. 89 No. 3, pp. 943–954.
- Guimera, R. and Amaral, L.A.N. (2005), "Cartography of complex networks: Modules and universal roles", *Journal of Statistical Mechanics: Theory and Experiment*, IOP Publishing, Vol. 2005 No. 2, pp. 1–13.
- Habermas, J. (1987), "The theory of communicative action. Vol.2, Lifeworld and system : a critique of functionalist reason", *Reason*, Vol. 2, p. 457p.
- Van der Hammen, T. and Andrade, G. (2003), *Estructura Ecológica Principal de Colombia, Informe Final. Instituto de Hidrología, Meteorología y ....*
- Hardin, G. (1968), "The tragedy of commons", *Science*.
- Harvey, D. (2008), *Spaces of Neoliberalization: Towards a Theory of Uneven Geographical Development, Progress in Human Geography*, Vol. 32, available at:<https://doi.org/10.1016/j.polgeo.2007.07.004>.
- Hess, D.J. (2013), "Industrial fields and countervailing power: The transformation of distributed solar energy in the United States", *Global Environmental Change*, Vol. 23 No. 5, pp. 847–855.
- Hess, D.J. (2015), "Undone science and social movements: A review and typology", *Routledge International Handbook of Ignorance Studies*, pp. 141–154.
- Hess, D.J. (2016), *Undone Science: Social Movements, Mobilized Publics and Industrial Transitions*,

MIT Press, Cambridge, Massachusetts: London England.

- Jamison, A. (2006), "Social movements and science: Cultural appropriations of cognitive praxis", *Science as Culture*, available at:<https://doi.org/10.1080/09505430500529722>.
- Javed, M.A., Younis, M.S., Latif, S., Qadir, J. and Baig, A. (2018), "Community detection in networks: A multidisciplinary review", *Journal of Network and Computer Applications*, available at:<https://doi.org/10.1016/j.jnca.2018.02.011>.
- Levi-Strauss, C. (1962), "Lévi-Strauss : La pensée sauvage", *La Pensée Sauvage*, available at:<https://doi.org/10.1177/014920639101700108>.
- Lubitow, A. (2013), "Collaborative Frame Construction in Social Movement Campaigns: Bisphenol-A (BPA) and Scientist-Activist Mobilization", *Social Movement Studies*, Vol. 12 No. 4, pp. 429–447.
- McAdam, D. (1999), *Political Process and the Development of Black Insurgency, 1930-1970*, Development, Vol. 2nd.
- McCormick, S. (2006), "The Brazilian anti-dam movement: Knowledge contestation as communicative action", *Organization and Environment*, Vol. 19 No. 3, pp. 321–346.
- Mische, A. (2003), "Cross-Talk in Movements: Reconceiving the Culture-Network Link", *Social Movements and Networks: Relational Approaches to Collective Action*, pp. 258–278.
- Newman, M.E.J. (Mark E.J.. (2018), *Networks*, Oxford University Press.
- Newman, M.E.J. and Girvan, M. (2004), "Finding and evaluating community structure in networks", *Physical Review E - Statistical, Nonlinear, and Soft Matter Physics*, available at:<https://doi.org/10.1103/PhysRevE.69.026113>.
- Palacio, D. (2017), "El lugar-red y la acción ambiental. Pistas para una gobernanza reflexiva y situada.", *Redes*, Vol. 28 No. 1, pp. 73–91.
- Palacio, D. and G. Hurtado H., R. (2005), "Narrativas y redes de la gestión ambiental de los humedales de Bogotá", *Nómadas*, Vol. 22, pp. 140–151.
- Palacio, D., Hurtado, R. and Garavito, L. (2003), "Redes socio-ambientales en tensión: el caso de la gestión ambiental de los humedales de Bogotá", *Redes.Revista Hispana Para El Análisis de Redes Sociales*, Vol. 4, pp. 1–31.
- Palacio, D.C. (1992), *A SOCIAL-ENVIRONMENTAL APPROACH TO FACILITATE SOCIAL PARTICIPATION IN THE MANAGEMENT OF PROTECTED AREAS*.
- Palacio, D.C. (2010), "La valoración ambiental participativa: Una perspectiva local para la construcción de territorios sostenibles. El caso de Soacha", *Colombia Revista Uis Humanidades*, Vol. 38, pp. 63–78.
- Della Porta, D., Diani, M. and Routledge, P. (2015), "Geography and Social Movements", *The Oxford Handbook of Social Movements*, available at:<https://doi.org/10.1093/oxfordhb/9780199678402.013.40>.
- Routledge, P. (2015), "Geography and Social Movement", *The Oxford Handbook of Social Movements*, pp. 383–395.
- Ruíz, A.G., Hes, E. and Schwartz, K. (2011), "Shifting governance modes in wetland management: A case study of two wetlands in Bogotá, Colombia", *Environment and Planning C: Government*

- and Policy, available at:<https://doi.org/10.1068/c10144>.
- Smith, A. (2006), "Green niches in sustainable development: The case of organic food in the United Kingdom", *Environment and Planning C: Government and Policy*, Vol. 24 No. 3, pp. 439–458.
- Smith, A., Fressoli, M. and Thomas, H. (2014), "Grassroots innovation movements: Challenges and contributions", *Journal of Cleaner Production*, Vol. 63, pp. 114–124.
- Smith, A. and Stirling, A. (2008), "Social-ecological resilience and socio-technical transitions: critical issues for sustainability governance", *Brighton STEPS Centre Working Paper*, Vol. 8 No. 8, pp. 1–25.
- SOWA, J.F. (1991), *Principles of Semantic Networks: Explorations in the Representation of Knowledge*, Morgan Kaufman Publishers, available at:<https://doi.org/10.1016/B978-1-4832-0771-1.50010-2>.
- Steyvers, M. and Tenenbaum, J.B. (2005), *The Large-Scale Structure of Semantic Networks: Statistical Analyses and a Model of Semantic Growth*.
- Sze, J. (2005), "Street Science: Community Knowledge and Environmental Health Justice", *Environmental Health Perspectives*, available at:<https://doi.org/10.1289/ehp.113-a558a>.
- Telesford, Q.K., Joyce, K.E., Hayasaka, S., Burdette, J.H. and Laurienti, P.J. (2011), "The Ubiquity of Small-World Networks", *Brain Connectivity*, Vol. 1 No. 5, pp. 367–375.
- El Tiempo, C.E. (1991), "Pantanos con vida de charco noviembre 3 de 1991", *El Tiempo*.
- Tilly, C. and Tarrow, S. (2007), *Contentious Politics*, Oxford University, NY:New York.
- Travers, J. and Milgram, S. (1969), "An Experimental Study of the Small World Problem", *Sociometry*, American Sociological Association, Vol. 32 No. 4, p. 425.
- Warf, B. (2007), "Spaces of Global Capitalism: Towards a Theory of Uneven Geographical Development, by David Harvey", *Journal of Regional Science*, Vol. 47 No. 2, pp. 394–396.
- Wen, B., Van Der Zouwen, M., Horlings, E., Van Der Meulen, B. and Van Vierssen, W. (2015), "Transitions in urban water management and patterns of international, interdisciplinary and intersectoral collaboration in urban water science", *Environmental Innovation and Societal Transitions*, Vol. 15, Elsevier, pp. 123–139.
- Yan, E. and Ding, Y. (2012), "Scholarly network similarities: How bibliographic coupling networks, citation networks, cocitation networks, topical networks, coauthorship networks, and cword networks relate to each other", *Journal of the American Society for Information Science and Technology*, available at:<https://doi.org/10.1002/asi.22680>.
- Young, O.R., Berkhout, F., Gallopin, G.C., Janssen, M.A., Ostrom, E. and van der Leeuw, S. (2006), "The globalization of socio-ecological systems: An agenda for scientific research", *Global Environmental Change*, Vol. 16 No. 3, pp. 304–316.

## Appendix 1: Map of wetlands in Bogota



## Appendix 2: Detail of interviews

Identifier	Role	Position
A	Social leader	Neighbour of The Cow Wetland
B	Social leader	Neighbour of The Cow Wetland
C	Social leader	Neighbour of Córdoba Wetland
D	Social leader	Environmental activist
E	Social leader and then director of Environmental department of Bogotá's Aqueduct and sewer Company	Neighbour of Córdoba Wetland
F	Youth leader	Leader in Wetlands foundation
G	Researcher on social movement of wetlands protection	Scholar
H	Local Government	Former advisor from District Department of the Environment
I	Local Government	Former advisor from District Department of the Environment